SCIENTIFIC INSTRUCTION AT THE IOWA STATE UNIVERSITY

THE *American Scientific Monthly* states that the faculty of the State University of Iowa have, with marked unanimity, resolved to recommend to the Board of Regents a new course of study for the first three years, in order to adapt the internal organisation of the institution to the spirit of the new organic law passed by the late General Assembly.

According to this plan, the students have four regular hours of work, lecture, or recitation each school day. This time is equally divided between the *letters* (language, history, &c.), and the *sciences* (mathematics, physical and natural science). The direction of these two classes of studies is to be respectively under the Faculty of Letters and the Faculty of Science, each to have complete control over one-half of the students' time.

Of the two hours spent in the different sciences, one hour is devoted to mathematics, the other, in the two first years to physical, in the third year to natural science. This order might, perhaps, with advantage to the student, be changed so as to have the second year in physical science succeed instead of precede the year in natural science; the student would thereby profit from his greater proficiency in mathematics.

After having completed this three-years' course—which is the same for all students in the sciences, but permits the student, under certain wholesome restrictions, to substitute the different languages one for the other—the student can intelligently decide whether he desires to graduate in the sciences, the letters, or in pedagogics. In the last case, he needs not to have studied any foreign language, but will have spent a great amount of time in the study of his vernacular and its literature; he may then enter the Normal Department, and, at the close of one year, receive the degree of B.D. (Bachelor of Didactics). If, however, he has studied foreign languages, especially Latin and German, he can, after two years of studies, selected according to his own pleasure from among the higher branches taught at the University, obtain either the degree of B.Ph. (Bachelor of Philosophy) or B.A. (Bachelor of Arts). To obtain the former, at least two-thirds of the studies selected by him must have been in the department of Science, while to obtain the latter degree the same fraction should have been studied in the department of Letters.

Facilities for part-graduate courses are also offered, and have, indeed, already been improved by several gentlemen in the past year. We abstain from giving forth details concerning this plan until the Board of Regents shall have taken action thereon. We believe, however, that this plan, in a judicious manner, combines the best features of the American College system with the German University system. It will equally prevent one-sidedness and class-drudgery; while securing familiarity with the *elements* of the principal branches of human culture, it will, at the same time, not only permit each mind to follow its own bend, but also give every individual a fair chance to ascertain correctly in what direction his mind leads him.

This new organisation is especially important to those interested in science. Hitherto, most students commenced the study of science after having spent several years in book studies, especially the dead languages. It seemed they had been imbued with the absurd notion that such studies form a proper preparation for the study of physical and natural science. Experience has, however, abundantly confirmed the common-sense view, that the exclusive pursuit of such literary branches, by permitting the faculties of observation and logical reasoning to slumber, does unfit students for the successful study of nature. For the sake of the student, we are glad that this system, at last, has been thoroughly abandoned. The students will hereafter commence the study of physical science immediately upon entering the University, and, in regular succession, become familiar with the elements and principles of the same. They will take up the natural sciences only after they have become familiar with the elements of physical science. Hereby the professors of physical and natural sciences will, at last, have an opportunity given to teach science in such a manner and at such a time as they deem necessary. We are glad to state that this great reform has the cordial support of each member of the faculty.

NEW CLASSIFICATION OF CLOUDS[*]

NO one is ignorant that the study of clouds is, from the point of view of our practical needs, one of the most important questions meteorology can present us. Indeed, there is no other meteorological manifestation can so fix the attention of the yeoman in the city, of the agriculturist in the country, of the tourist on the mountain's summit, of the soldier in war, of the sailor in continual strife with the disturbances of atmosphere and sea, and, in fine, of the savant in general.

We everywhere see these different social elements continually watching the diverse appearances which the clouds offer us, and casting upon them a look of interrogation, of disquietude, of desire, of a wish constantly renewed to grasp their forms, in order to predict good or bad weather, according to our social needs.

It is especially when the atmosphere threatens some perturbation, rain, storm, tempest, that the common people examine the character of the clouds. But how often, at every moment of the day, do they ask each other about the temperature, hot, cold, or wet, which sensibly exists, while just as often do they pass by unheedingly the clouds, which exert a no less direct or indirect action upon atmospheric variations, as well in the abnormal state as in the normal.

Moreover each country, according to its geographical position, topography, &c., has its own type of clouds. Here the *Cirrus* predominates, there the *Cumulus*, elsewhere such and such form of clouds which do not exist in other places. All these different appearances of clouds are everywhere intimately connected with some particular condition of climate, and these climatological conditions powerfully influence, in their turn, the health, agriculture, navigation, and the thousand other social concerns of humanity. We may say that the clouds are a great book of nature, constantly open for the perusal of all classes of society. Like a compass, the clouds show us at every instant the direction, the velocity, and the altitude of the superior currents which afterward determine the inferior winds at the surface of the earth. There is, therefore, a permanent weathercock as long as the sky contains a single cloud, however small it may be.

There is necessity, therefore, for undertaking a profound study of clouds in their diverse scientific and social applications; for making researches upon the *nature, form, quantity, direction, velocity*, and *azimuthal rotation* of clouds, corresponding to each stratum perfectly characterised by the origin, intimate constitution, and meteoric products of the vesicular vapours and congealed particles which constitute them. For, in the intimate nature of clouds there is a fundamental condition to be established, which results from the physical force acting immediately after gravitation, upon their constitution. This is the element of *heat*.

Despite this scientific interest, despite this practical need which each feels, and which is so universally acknowledged, despite all this, the study of clouds is yet unhappily in its infancy. It is rarely one sees "clouds" inscribed in the meteorological registers of observatories, and when they are, the registrar has wholly neglected to note their form, their quantity, their direction, their velocity, and their azimuthal rotation. Some say simply, "clouds;" others mention the form or the quantity, may be the direction, or exceptionally these three elements, but assuredly they neglect the velocity, and especially the azimuthal rotation which I have first signalised in clouds, and which is not yet understood. In fine, not a single register gives these five elements for one stratum of cloud, much less for each distinct stratum of those which very often appear superposed in the atmosphere.

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[*] Contributed by Prof. Poey, of Havana, to the Semi-Annual Session of the National Academy of Sciences, held at Washington.

We now proceed to present the basis of a new classification, more in harmony with the actual data of the science, and which is the fruit of twenty years' assiduous study upon the clouds, in the Antilles, as well as in Mexico, the United States, and Europe. From the beginning (at that date) of my meteorological studies at Havana, a city situated in the tropics where the *ensemble* of atmospheric phenomena affects an extreme simplicity in consequence of their surprising regularity, which is effaced as we approach the higher latitudes, ever since, I say, I have more and more felt the necessity of reforming Howard's nomenclature. For a long time I was unable to understand the four cloud formations, which I had come to reject, namely: Stratus, Nimbus, Cumulo-Stratus (different forms of Cumulus), and Strato-Cumulus. It was only later that, having been able to consult Howard's original work, I perceived the errors into which Kaemtz and all the meteorologists had fallen. I have, then, to introduce into Howard's classification the essential modifications which the continued progress of meteorology now requires, in order that the nomenclature may be more in harmony with our new conquests. I acknowledge with pleasure that Howard's classification of clouds, which has ruled without a rival for more than half a century (A.D. 1802), was originally based upon a profound study, directed by great acuteness in the observation of facts. But unhappily this is too plainly stamped with the locality where Howard's studies were alone prosecuted. I am speaking of the gray and cloudy sky of Great Britain, whence are his *Strato-mist*, his imperfect distinction of the two strata *Cirrus* and *Cumulus*, or his *Nimbus* (the rain cloud), the difference which he has established between *Cumulus* and *Cumulo-stratus*, without counting many other details of description, which are faulty, in relation to Cirrus, Cirro-stratus, and Cirro-cumulus.

Here is now the vindication of my three new clouds. When certain clouds are spread out uniformly, cover the whole face of the heavens, take a gray or ash-colour, under which state rain may occur for hours and whole days, what name do we give to these clouds? They are not Howard's *Nimbus*, as we conceive them and as they are generally described. These clouds are neither stormy, nor have they electrical manifestations, there is only a fine and continuous rain. Under this stratum—for it is a true stratum—we see constantly other clouds more or less considerable, but always isolated, come to be lost in it and to increase its thickness. On the contrary, before this stratum begins to break up, and during this operation, we see these same formless fragments detach themselves and fly to other regions. This inferior stratum is not alone, for when its disruption has taken place we see through it another stratum of clouds, whiter and less dense, which is broken up in its turn, and ends by disappearing in an inverse order to that of the first inferior stratum. Have we a name for this variety of cloud, so common in time of rain from the inter-tropical regions to high latitudes, especially in winter, during falls of snow? Does Howard's term Nimbus and his description of it account for this sort of cloud? Certainly not. We name indifferently a *Nimbus*, the single storm cloud, as well as this inferior stratum, or yet the two united strata, and all this without electrical manifestations. This is what I call *Pallium*; that is to say, those strata of which the superior is formed of *Cirrus*, constitute the *Pallio-cirrus* and the inferior of *Cumulus* constitute the *Pallio-cumulus*. The fragments of clouds which differ entirely from the *Cumulus* or *Cumulo-stratus* are the *Fracto-cumulus*.

Hence we see the necessity of distinguishing these two strata by different names; Howard's unique name of Nimbus did not do this, while granting him the greatest descriptive exactitude, which he is far from possessing. This necessity results moreover from the fact that the stratum of *Cirrus* is formed many hours, and even many days, before that of *Cumulus*, especially in the equatorial regions, and in fine that the latter disappears first. Without this distinction we are obliged to call the first stratum *Cirrus* and the second *Cumulus*; but as under this state of strata the form and physical properties of Cirrus and Cumulus change completely, there results the confusion and errors daily committed.

As regards Howard's classification as a whole, while retaining the two types of *Cirrus* and *Cumulus*, with his two derivative clouds, *Cirro-stratus* and *Cirro-cumulus*, I reject entirely his *Stratus*, his *Nimbus*, and his *Cumulo-stratus*, together with the *Strato-cumulus* of Kaemtz, for the following reasons: *Stratus*, because it is not (according to Howard) a cloud properly so-called, but a *mist* or *hoar frost*, or yet by the effect of an optical illusion, a *Cirrus*, a *Cirro-stratus*, or a *Cirro-cumulus*, as seen in perspective at the horizon; *Nimbus*, for the reason that it is an inexact denomination which is moreover applied to an idea as vague as incorrect, from the moment that *Cumulus* is not truly rainy as far as it is found displayed, forming a stratum as dense in appearance and below a second superior stratum of *Cirrus*, equally rainy; *Cumulo-stratus*, because it differs in nothing from Cumulus, according to Howard's own definitions, the three fundamental characters of cloud type and of its derivations being common to these two forms, namely: their horizontal bases, their superior hemispherical basins, and the ascending aggregation of their aqueous particles; in fine, *Strato-cumulus* (Kaemtz's cloud of night), because this modification answers in no manner, no more than Howard's *Stratus* to *clouds of night*, and because, on the contrary, its other characteristics correspond to *Cumulo-stratus*.

On the other hand, I substitute for *Nimbus* the *Pallium*, which I sub-divide into *Pallio-cirrus* and *Pailio-cumulus*, according as its stratum is composed of *Cirrus* or *Cumulus*. This term has the triple advantage of embracing the character, the form, and the effect—that is to say, the *Cirrus* or *Cumulus* forming a rainy stratum. I introduce, in fine, the determination of a second transitorial form, which seems to me can be rigorously distinguished from the preceding in the double relation of cause and effect. This is the *Fracto-cumulus* fragments of clouds which are wandering about without determined form, before their transformation into *Cumulus* (or *Cumulo-stratus*), which are precipitated or detached from the inferior surface of the stratum of *Sallio-cumulus*, and which, in fine, are spread out in horizontal bands at the summit of the *Cumulus* on the approach of gusts of wind. These *Fracto-cumulus* differ from the Cumulus in this: they have neither the horizontal base nor the superior hemispherical basins while they are not very extended; but as soon as they become a little more increased we see at once forming at the centre of the fragment a space more dense and blackish than the rest, which gradually settles until it constitutes the horizontal base of the *Cumulus* (*Cumulo-stratus*), the upper part also becoming rounded by degrees. Thus the *Fracto-cumulus* is the infancy of the *Cumulus*, otherwise called *Cumulo-stratus*, the terms being synonymous.

This new classification is wholly based upon the *nature*, the *form*, the *quantity*, the *direction*, the *velocity*, and the *azimuthal rotation* of the clouds corresponding to each stratum fully characterised by the origin, intimate constitution and meteoric products of the vesicular vapours and congealed particles which constitute them. For, in the intimate nature of clouds there is one fundamental condition to be established depending upon the physical force which first acts upon their constitution; it is the element of *heat*. Clouds are therefore distinguished into *snow clouds* and *ice clouds*, of which the constituent particles are more or less congealed; then into *clouds of aqueous vapour*, of which the vesicles, empty or full, float in a medium above the freezing point.

Under this fundamental aspect there are but two types of clouds properly so called, the *Cirrus* and the *Cumulus*. To the *Cirrus* are attached three transitional forms: the *Cirro-stratus*, *Cirro-cumulus* and *Pallio-cirrus*; and to the *Cumulus*, two other transitional forms; the *Pallio-cumulus* and the *Fracto-cumulus*.

Here is a table of my new classification of clouds compared with that of Howard:

NEW NOMENCLATURE OF POEY

First type.	*Cirrus*	Ice clouds.
Derivative	Cirro-stratus	
	Cirro-Cumulus...	Snow clouds.
	Pallio-cirrus......	
Second type.	*Cumulus*...........	Vesicular clouds of aqueous vapour.
Derivatives	Pallio-cumulus....	
	Fracto-cumulus...	

OLD NOMENCLATURE OF HOWARD.

First type.	*Cirrus*
Derivatives	Cirro-stratus. Cirro-cumulus.
Second type	*Cumulus.*

Derivatives—Cumulo-stratus.
Third type *Stratus*,
Derived from the three types—*Nimbus*.

My nomenclature appears probably more in accordance with the nature of the clouds in this sense than the two types, *Cirrus* and *Cumulus*, are rigorously based upon the constitution of ice and snow-clouds of aqueous vapour. Where there is no proof of the existence of Howard's third type, being that, according to this savant, it is a mist which overspreads the earth at sunset, but which is raised in the morning at the first appearance of that luminary. As to number, my nomenclature offers the same determination of cloud forms, that is to say, seven—the two types and five derivatives.

The order in which the clouds are placed in my table correspond, at the same time, to the order of their appearance, from the highest region of the *Cirrus* down to those nearest the earth, where the *Fracto-cumulus* are produced, according as the vapour of water passes from the state of frozen particles to that of aqueous vesicles, or *vice versa.* However, the *Pallio-cumulus*, which serves as a transition between the two types and their derivatives, is found a little more elevated than the *Cumulus.*

I have thought it suitable to modify Forster's vulgar nomenclature by substituting other names more in harmony with the form and nature of the clouds. I give in continuation the old and new classification :

	Forster's Nomenclature	Poey's Nomenclature
Cirrus	Curl-cloud.	Curl-cloud
Cirro-stratus	Wane-Cloud.	Thread-cloud
Cirro-cumulus	Sonder-cloud.	Curdled-cloud
Pallio-cirrus		Sheet-cloud
Cumulus.	Stacken-cloud	Mount-cloud
Pallio-cumulus.		Rain-cloud
Fracto-cumulus		Wind-cloud

With the exception of Cirrus, whose name, "Curl-cloud," approaches nearest the form of this species of cloud, all the determinations have been changed. The Pallio-cumulus replaces the Nimbus, also named "Rain-cloud."

I.—CIRRUS (HOWARD).

Cirrus, so named by Howard ("the cat's tail," of sailors), are composed of filaments, whose *ensemble* resembles sometimes a curled hair, a twisted tuft, plumage, the flowing tail of a horse, at other times they are disposed in long, straight bands parallel to each other, or divergent palmated, or like a fish bone or vertebral column, their greater axis being oriented according to the sailing of the cloud and the direction of the wind existing at that altitude, which is not slow in making itself felt on the earth. When they form two or more systems of straight parallel bands, by an effect of perspective, they appear to diverge from their point of departure at the horizon and to converge toward the point of the horizon diametrically opposite, as do the rays of the rising or setting sun.

The *Cirrus* have always a whiteness, sometimes brilliant, sometimes pearly dull. The earliest and the latest reflections of the solar rays upon the clouds colour them with a charming rose tint, more or less intense, according to their density. Their propagation is excessively slow, and their altitude is not less than 10,000 metres (more than six and a quarter miles). These clouds are the highest, slowest, most rarified, most variable in their forms, and the most extended. The appearance and disappearance of *Cirrus* proclaim simultaneously the end and the commencement of good weather. The barometer sinks and then rises, the *ensemble* of meteorological accompanying phenomena pursuing the same course. We quote from Howard :

"They are first indicated by a few threads pencilled, as it were, on the sky. These increase in length, and new ones are in the meantime added to them. Often the first formed threads serve as stems to support numerous branches, which in their turn give rise to others.

"The increase is sometimes perfectly indeterminate ; at others it has a very decided direction. Thus the first few threads being once formed, the remainder shall be propagated in one or more directions laterally, or obliquely upward or downward, the direction being often the same in a great number of clouds, visible at the same time ; for the oblique descending tufts appear to converge toward a point in the horizon, and the long straight streaks to meet in opposite points therein, which is the optical effect of parallel extension. The upward direction of the fibres or tufts of this cloud is found to be a decided indication of the decomposition of vapour preceding *rain* ; the downward as decidedly indicates *evaporation* and fair weather. In each case they point toward the place of the electricity which is evolved at the time.

"Their duration is uncertain, varying from a few minutes after the first appearance to an extent of many hours and even days. It is long when they appear alone and at great heights, and shorter when they are formed lower and in the vicinity of other clouds.

"This modification, although in appearance almost motionless, is intimately connected with the variable motions of the atmosphere. Considering that clouds of this kind have long been deemed a prognostic of wind, it is extraordinary that the nature of this connection should not have been more studied, as the knowledge of it might have been productive of useful results.

"In fair weather, with light, variable breezes, the sky is seldom quite clear of small groups of the oblique *Cirrus*, which frequently come on from the leeward, and the direction of their increase is to windward. Continued wet weather is attended with horizontal sheets of this cloud, which subside quickly and pass into the *Cirro-stratus.*

"Before *storms* they appear lower and darker, and usually in the quarter opposite to that from which the storm arises. Steady high winds are also preceded and attended by streaks running across the sky in the direction they blow in."

II.—CIRRO-STRATUS.

Thread-cloud.—Howard's *Cirro-stratus* is distinguished from the pure *Cirrus* by its filaments being smaller, more compact, more ramified, and, so to say, completely stratified. They are lower, more dense, for often the sun's rays pierce them with difficulty. Their whitish tint is clearer, and it also becomes rose colour in similar circumstances. Their motion is a little more rapid. When at the horizon, we only seeing the vertical projection, they take the appearance of a long and very narrow band. Howard says :

"This cloud appears to result from subsidence of the fibres of the *Cirrus* to a horizontal position, at the same time that they approach each other laterally. The form and relative position, when seen in the distance, frequently give the idea of shoals of fish. Yet in this, as in other instances, the *structure* must be attended to rather than the *form*, which varies much, presenting at times the appearance of parallel bars, or interwoven streaks like the grain of polished wood. It is thick in the middle, and extenuated towards the edge. The distinct appearance of a *Cirrus*, however, does not always precede the production of this and the last modification.

"The *Cirro-stratus* precedes *wind* and *rain*, the near or distant approach of which may sometimes be estimated from its greater or less abundance and permanence. It is almost always to be seen in the intervals of storms. Sometimes this and the *Cirro-cumulus* appear together in the sky, and even alternate with each other in the same cloud, when the different evolutions which ensue are a curious spectacle ; and a judgment may be formed of the weather likely to ensue by observing which modification prevails at last. The *Cirro-stratus* is the modification which most frequently exhibits the phenomena of the Solar and Lunar halo, and (as supposed from a few observations, the Parhelion and Paraselene also. Hence, the reason of the prognostic of foul weather—commonly drawn from the appearance of Halo. The frequent appearance of Halo in this cloud may be attributed to its possessing great extent, at such times, with little perpendicular depth, and the requisite continuity of substance.

"This modification is, on this account, more peculiarly worthy of investigation."

III.—CIRRO-CUMULUS.

Curdled Cloud.—It is sufficient that the *Cirro-stratus* sink a little, or that the temperature of the region they occupy be slightly elevated, in order that the frozen aiglets may be reduced to snow, and give birth in consequence to Howard's *Cirro-cumulus.* In the first place the axes of the *striæ* grow round ; then, by degrees, the entire stratification becomes so, until it forms little balls or corded cotton which we call "frizzled" clouds of "curled" sky (in French, *montonnes* or *pommele,*) when it is completely covered ; in Spanish, *cielo empedrado.* On the contrary, if the *Cirro-cumulus* are elevated a little, or if the temperature is lowered, they return to the superior type of *Cirro-stratus.* The little balls of snow are congealed and crystallised anew into aiglets.

The *Cirro-cumulus* are more dense and lower than the *Cirro-stratus*, from which they are derived, although generally the edges of the small agglomerations or of the entire mass of cloud is transformed into *Cirro-stratus*, whenever, by a greater elevation or a lower temperature, the congelation is more vigorous. Their motion is also more rapid, their colour slightly greyish, and they may, moreover, be tinged rose-colour, or, rather, become reddish.

The *Cirro-stratus*, but more especially the *Cirro-cumulus*, are remarkable by reason of a characteristic of the highest importance, from the point of view of the distribution of congealed aqueous vapour, and one which has escaped the sagacity of Howard and his successors. It consists in the most fantastical combinations, reproducing all the formations, hydrological, and physical, of our Continent and seas. Here a deep bay with promontories, capes, peninsulas, isthmuses, &c.; there, a river, brooks, lakes, &c.! further on, vast continents and open seas. The entire mass and the outlines of each of these accidents are besprinkled with *Cirro-cumulus*, sometimes edged with *Cirro-stratus*, of which the volumes of little balls are seen diminishing and vanishing from centre to circumference, while at the side, in the empty spaces, we perceive the purest azure of the heavens. Should it be a lake, the water will be represented by the blue sky, and *terra firma* by the *Cirro-cumulus* which surrounds it. By carefully studying all these transformations we remark in them the greatest analogy with the phenomena of the precipitation and congelation of dew upon solid bodies. There is, therefore, at this altitude, in the same stratum, and one after the other, so to say, some portions of the atmosphere enjoying different degrees of density and of temperature, in order that the congelation of aqueous vapour may take place in so variable a manner.

The influence of *Cirro-cumulus* upon the lowering of the temperature at the surface of the earth is so considerable that the human body feels it at once. A curdled sky at the new moon of a calm night in the tropics is a sky relatively glacial for these latitudes.

This effect may be due to their greater proximity and to the considerable quantity of balls of snow which constitute this type of cloud. The *Cirrus* being found much elevated and the *Cirro-stratus* much less abundant, although both are formed of glacial aiglets, have not the same influence upon the terrestrial temperature. Howard says:

"The *Cirro-cumulus* is formed from a *Cirrus*, or from a number of small separate *Cirrus*, by the fibres collapsing, as it were, and passing into small, roundish masses, in which the texture of the *Cirrus* is no longer discernible; although they still retain somewhat of their relative arrangement. This change takes place throughout the whole mass at once, or progressively from one extremity to the other. In either case the same effect is produced on a number of adjacent *Cirrus* at the same time and in the same order. It appears in some instances to be accelerated by the approach of other clouds.

"This modification forms a very beautiful sky, sometimes exhibiting numerous distinct beds of these small connected clouds, floating at different altitudes.

"The *Cirro-cumulus* is frequently seen in summer, and is attendant on warm and dry weather. It is also occasionally and more sparingly seen in the intervals of showers and in winter. It may either evaporate or pass to the *Cirrus* or *Cirro-stratus*."

Under the generic name of *Pallium*, I have classed two forms of clouds, which present the appearance of a mantle or veil of considerable extent, of very compact texture, well defined at the edges, of an excessively slow march, and embracing, moreover, the visible vault of the sky. According as the *Pallium* is formed of *Cirrus* or of *Cumulus* it is distinguished into *Pallio-cirrus* and *Pallio-cumulus*. The appearance of these clouds signalises bad weather, and their disappearance good weather.

The stratum of *Pallio-cirrus* is first formed, and some hours or some days afterwards that of *Pallio-cumulus* is formed under it. These two strata remain in view at a certain distance from each other, and by their reciprocal action and reaction produce storms and the heavier rains, accompanied with considerable electric discharges. They are electrified, but with contrary signs; the superior stratum of *Cirrus* is negative, and the inferior one of *Cumulus* is positive, the same as the rain which it disengages; while the electricity of the air, at the surface of the earth, is negative. But when these two strata attract each other a discharge is produced; and the inferior stratum continues to pour out the surplus water it contained without giving any sign of electricity, no more than the air in contact with the earth. This state continues until the inferior stratum opens up, the superior afterward, they then disappear, the one after the other. Fine weather then returns. The *Pallium* chiefly predominate during the rainy season, in inter-tropical regions, and in the higher latitudes during winter, at the time of falls of snow. A part of the *Pallio-cumulus*, which has not been reduced, or which has not been scattered to other regions, gathers at the horizon and is transferred into the *Cumulus*. As to the *Pallio-cirrus*, they disappear entirely if fine weather is maintained.

THE ANCIENT LAKES OF WESTERN AMERICA, THEIR DEPOSITS AND DRAINAGE *

THE wonderful collections of fossil plants and animals, brought by Dr. Hayden from the country bordering the Upper Missouri, are from deposits made in extensive fresh-water lakes which at one time occupied much of the region lying immediately east of the Rocky Mountains. The water of these lakes was first salt or brackish, as the remains of oysters and similar estuary forms show. By continental elevation the whole country west of the Mississippi was raised out of the cretaceous sea, and these estuaries became lakes inclosed by raised dry land. The knowledge of this country from the Mississippi to the Pacific Ocean has been accumulated by various explorers besides the writer, as Dr. Hayden, Mr. George Gibbs, Professors W. P. Blake and Thomas Antisell, and Prof. J. D. Whitney and the State Geological Survey of California, and Baron Richtofen, the lamented Rémond, Drs. Shiel, Wislizenus, and others. Besides Mr. Clarence King has explored a large tract of this country, but his very important contributions have not, as yet, been made public. The general character of the topography of the region west of the Mississippi has been given by these great lines of elevation traversing the country from north to south. There are the Rocky Mountains, the Sierra Nevada, and the Coast Ranges. The last is the most modern, and is composed, for the most part, of Miocene Tertiary rocks. Parallel with this lies a narrow trough, in California traversed by the Sacramento and San Joachin Rivers, encroached on by the mountains at places, but still in Oregon and Washington, traversed by the Willamette and Cowletz Rivers. These two sections are drained through the Golden Gate and Columbia. The mountain barriers formerly caused the valleys to consist of great inland lakes, which are now only represented by the chain of small pieces of water still to be seen in that region of country. East of the Sierra Nevada and between it and the Rocky Mountains is another still larger basin. For a thousand miles it has no openings to the westward, which are less than five thousand feet above the sea, but at three points there are gateways, which may be passed, but little above the sea level. These are the *canons* of the Sacramento (Pit River), the Klamath, and the Columbia. These have been cut through by the drainage of the interior of the continent. The former beds of the lakes have thus been left dry and waste—the only real desert on the North American continent. The Sierra Nevada is older than the Coast Ranges, and projected above the ocean, though not to its present altitude, previous to the Tertiary and even Cretaceous ages. This we learn from the fact that strata belonging to these formations cover its base. The mass of the Sierra Nevada is granitic rocks and metamorphic slates, proved by the California Survey to be triassic and jurassic. These slates are traversed by the gold-bearing quartz. East of the Sierra Nevada is a high and broad plateau five hundred miles wide, and from four to eight hundred feet in altitude, and reaches south into Mexico. This mountain belt was once the margin of the Pacific Ocean. Its crest is crowned by volcanic cones like gigantic towers of a fortification. The central portion of this plateau was called by Fremont "the great basin," as it forms a hydrographic basin drained by the Columbia and Colorado. The former makes its way to the ocean through a gorge in the Cascade Mountains, whilst the latter escapes to the south through a series of *canons*, of which the most important is nearly a thousand miles in length, and from three to six thousand feet deep. In vol. vi. of the Pacific Railroad Reports the country of the Columbia is described and the reasons for concluding that it had cut its way through the Cascade Mountains, and similar facts were observed in the district drained by the Klamath and Pit Rivers. Certain peculiarities are to be seen in the country between the Sierra Nevada and Rocky Mountains. In the northern and middle portions of the great table lands the surface is somewhat thickly set by short and isolated mountain ranges, sometimes called "the lost mountains." These rise like islands above the level of the plain, and are generally com-

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* Contributed by Professor J. S. Newberry to the Proceedings of the New York Lyceum of Natural History.